Lime Village, Alaska
Village Power Project

Hybrid Generation Simulator
HybSim 3.3

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US DOE Energy Storage Program

Peer Review Meeting

November 11, 2004

Agenda

- **Lime Village, Alaska Test-bed and Data Acquisition Project**
- **Hybrid Generation Simulator Software**
 - HybSim 3.3 FY04 Progress
- **Future Tasks**
- **Questions**

Lime Village Test Bed

➢ **Provide test bed to study Alaskan village generation characteristics to improve system performance.**

➢ **Provide real time data via satellite link for system performance analysis**

➢ **Optimize system design and performance utilizing HybSim model**

➢ **Provide the people of Lime Village with a cost effective and reliable power system.**

Lime Village Test Bed and Data Acquisition
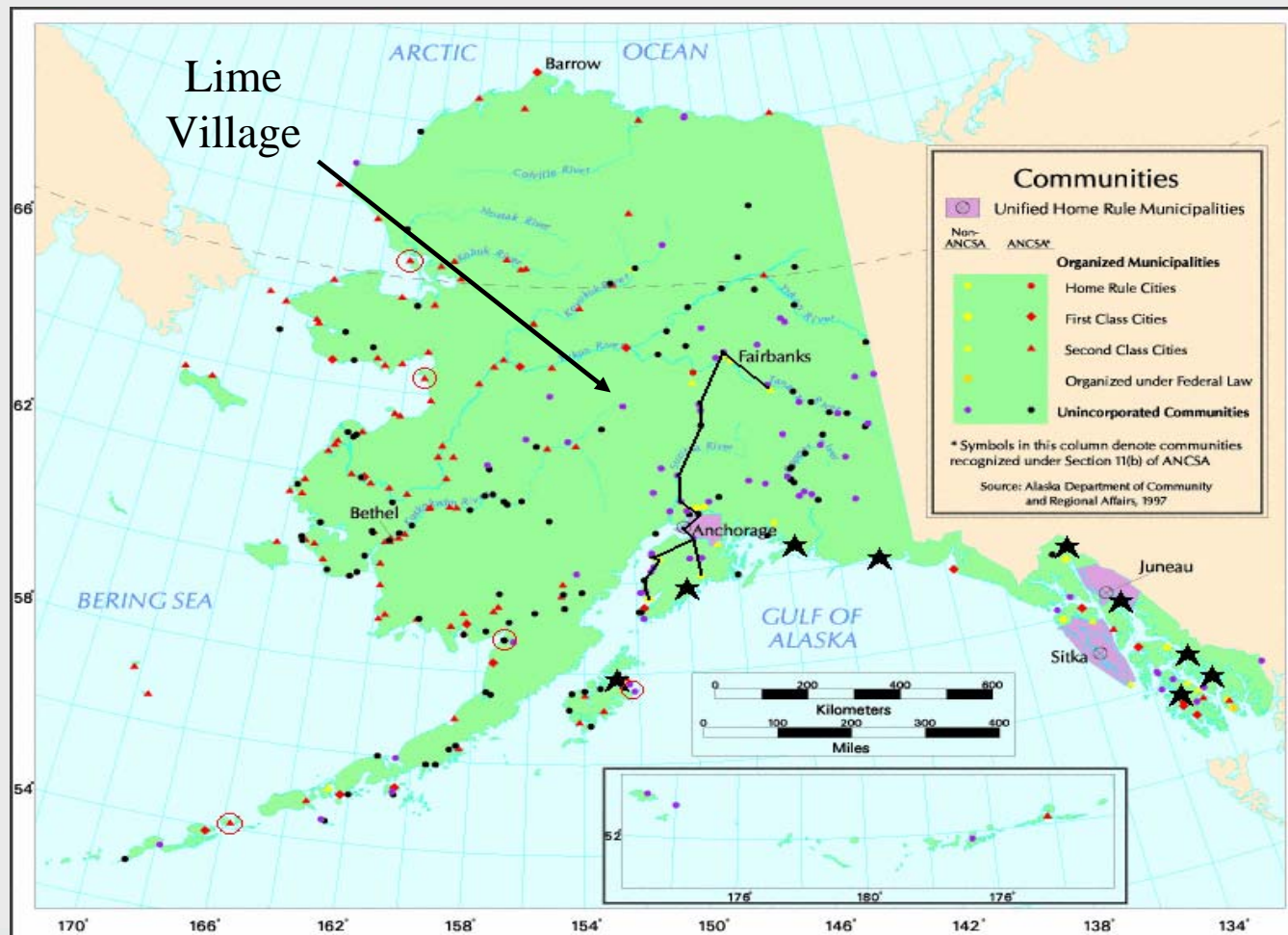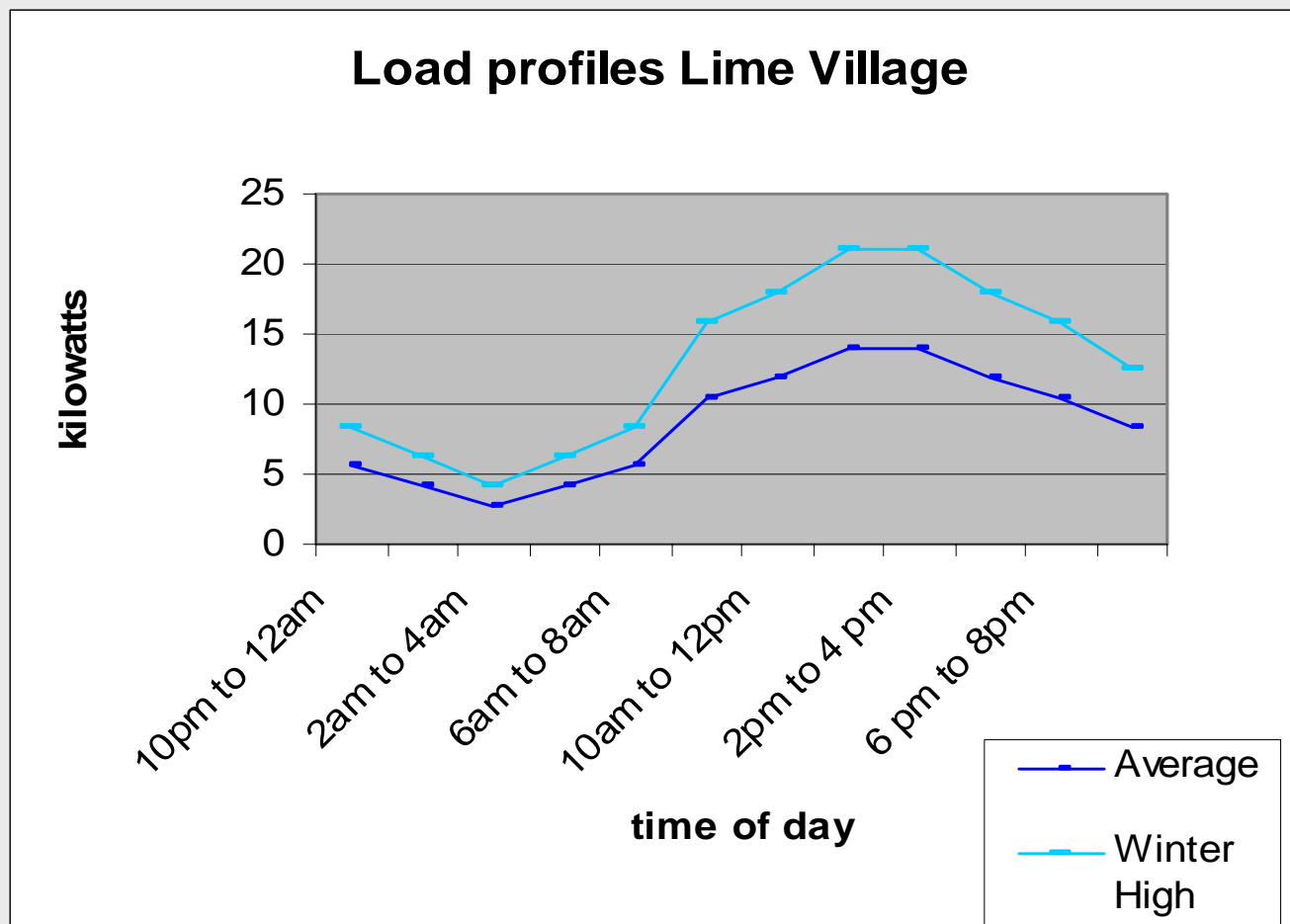
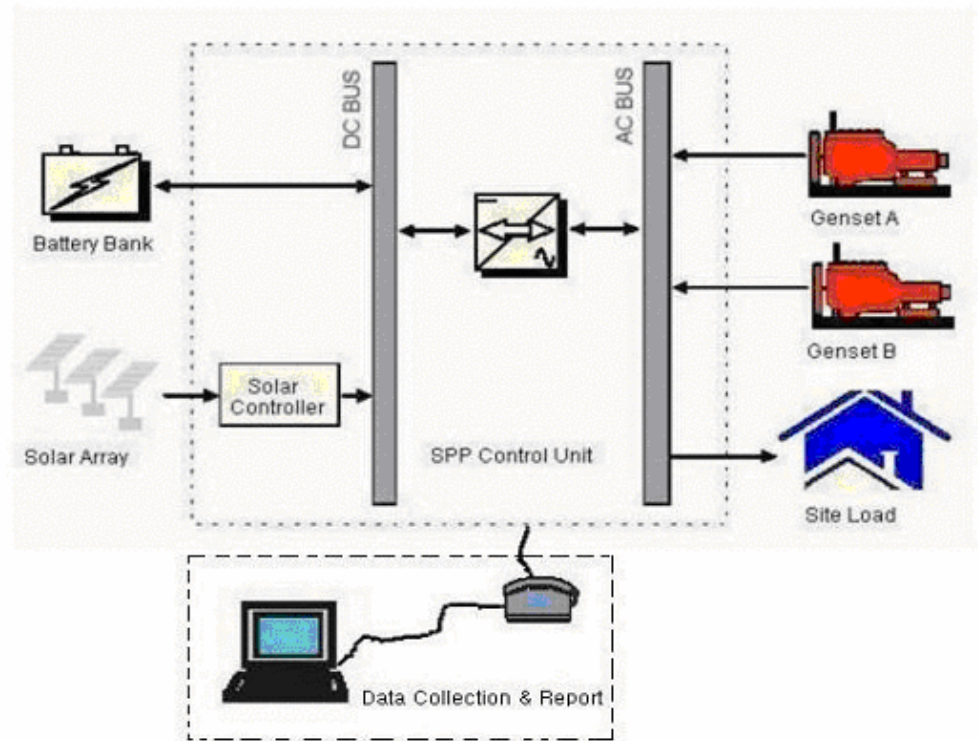# Lime Village, Alaska

Lime Village

Lime Village, Alaska

Alaska Modeling and Analysis Project

Load profiles Lime Village
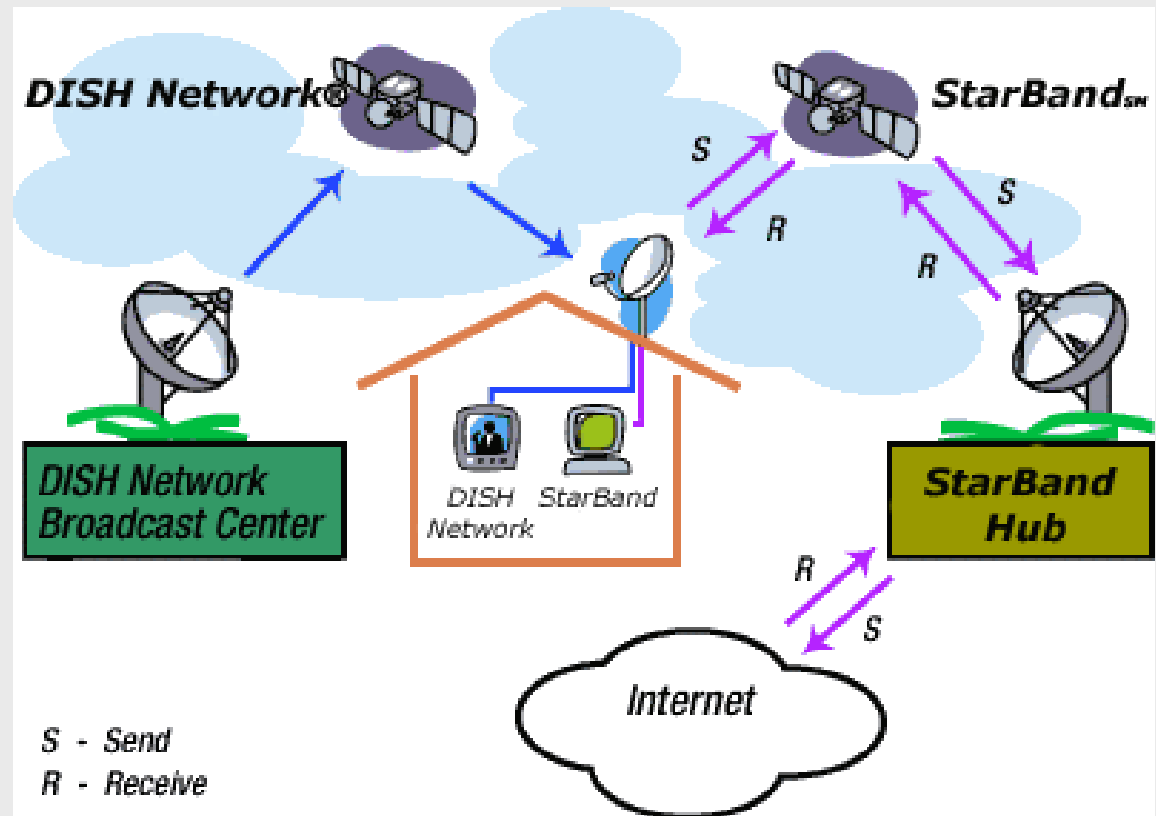
Lime Village System Configuration

Energy Costs ~ $0.56/kwh

- ➢ 22 kW diesel genset
- ➢ 35-kW diesel genset
- ➢ 5 strings of 15 Siemens SM55 PV panels (4-kW)
- ➢ 7 strings of 15 BP Solar BP275 PV panels (8-kW)
- ➢ 24 kW inverter
- ➢ 530 Ahr battery lead-acid

Data Transmission

- ➢ **Low cost**
- ➢ **Accessible**
- ➢ **Reliable**

DISH Network®

StarBand℠

S

S

R

R

DISH Network
Broadcast Center

DISH   StarBand
Network

StarBand
Hub

R

S

Internet

S - Send
R - Receive

Lime Village Test Bed Project Results

- **Improved Lime Village System Performance**
  - Identified Inverter Performance Problems
    - (7-kW charge limit)
    - Battery failure analysis

  - Analyzed Lime Village power factor problem (pf = 0.6)
  - Battery Cycle Charging versus Peak Shaving
  - Optimum Replacement Battery Sizing
  - Improved maintenance planning
    - Determined system components expected lifetime

- **Lime Village data acquisition system set the stage for further AEA funded data acquisition projects**

HybSim Program

➢ **Designed as simple, easy-to-use modeling tool.**

➢ **Designed for "Non-Ph.D." users.**

➢ **The program was written in Visual Basic for Applications inside Microsoft Excel**

  ➢ HybSim 3.3 operates as a sophisticated *Excel Macro*

  ➢ Compares diesel-only with hybrid power systems

➢ **All required input data is entered on Excel spreadsheets**

➢ **All simulation results are output on Excel spreadsheets and/or Excel graphs**

Input Dialog Boxes

Hybsim dbp - A hybrid power system simulator

Village | Generator-only System | Hybrid Generators | Battery/Power Electronics | Renewables | Fuels/Fuel Storage

Load Saved Simulation

Simulation Name

☐ Save simulation before run   Load Simulation

General Information

Location Name
Description

Load Profile File

Load Profile Sheet

Output File

Weather Data

Longitude (deg)   Elevation (m)

Latitude (deg)   Time Zone

Weather Data File

Weather Data Sheet

Dispatch Algorithm

○ Peak Shave

○ Cycle Charge

Battery Setpoints:
Charge Cutoff (V/cell)

Discharge Cutoff (V/cell)

Economic Analysis Details

System Life (yr)

Discount Rate (%)

Power Factor

Village Power Factor

HELP   STORE   RUN   QUIT
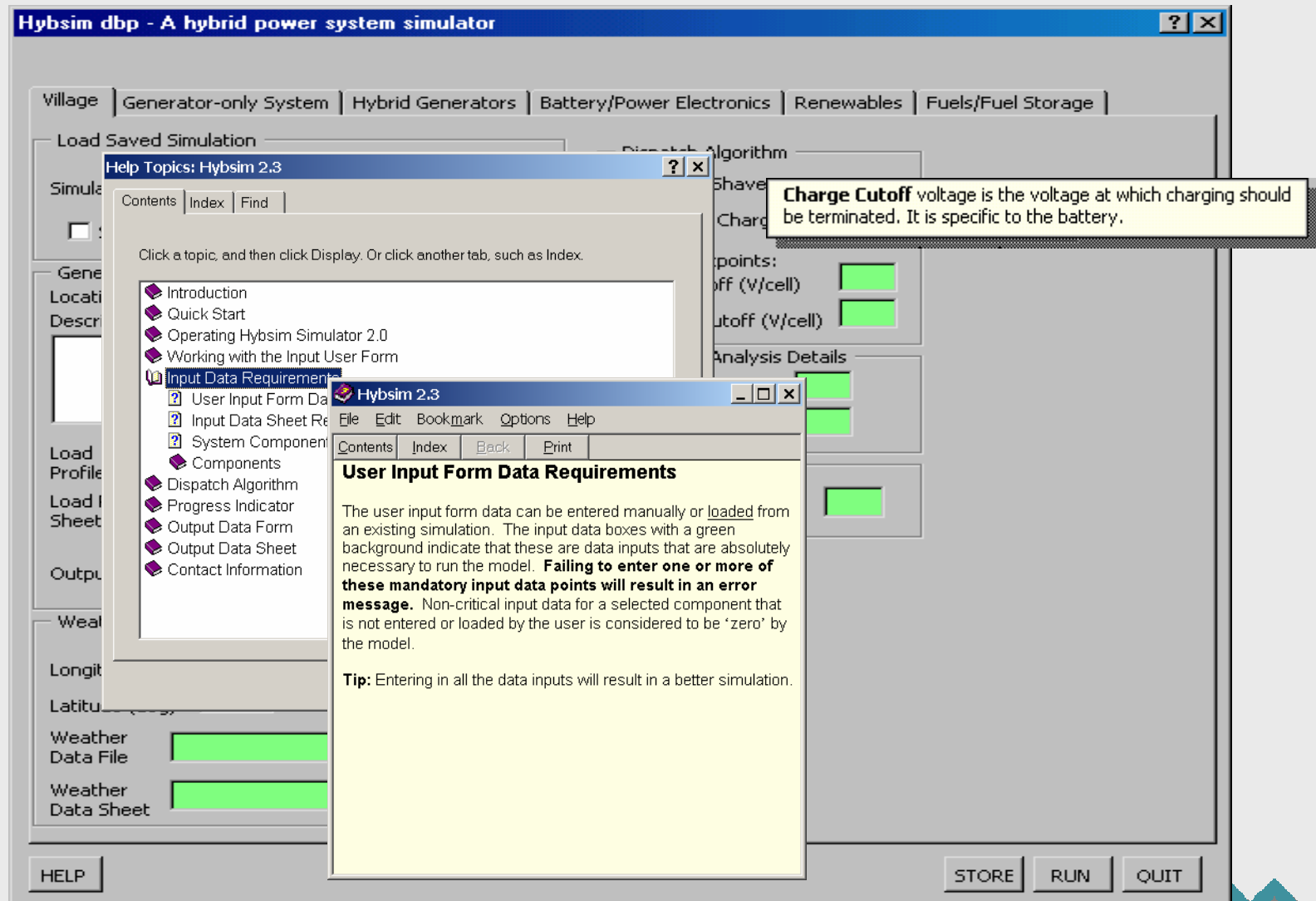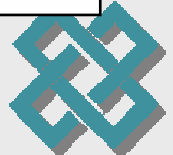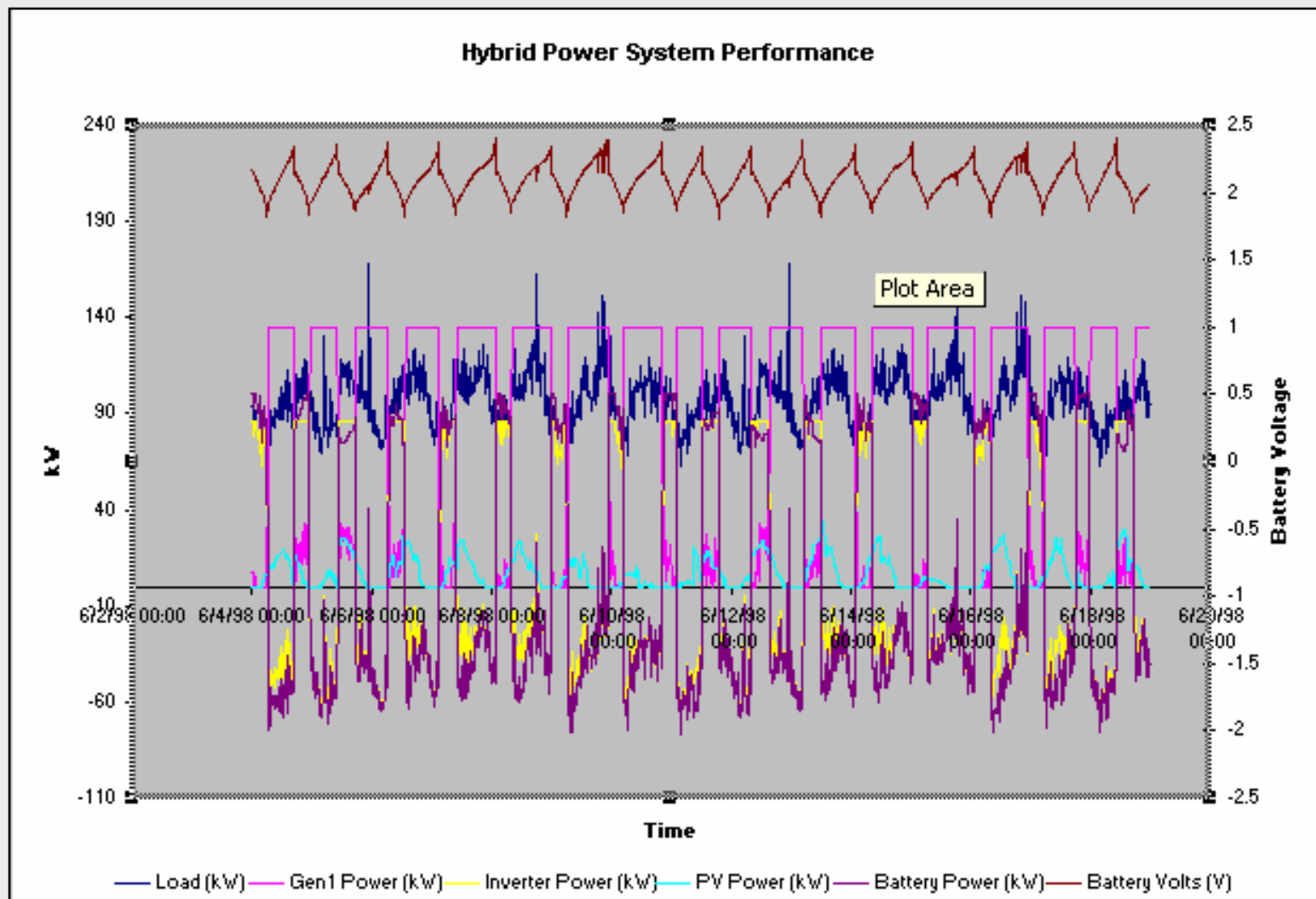
Note:

Green boxes are *essential data*. The model will not run without these values being entered into the program.

Context Sensitive Help Screens

Plot of System Performance

Hybrid Power System Performance

Hybrid Generation Simulator Modeling Tool

➢ **FY04 Progress**

➢ Develop User's Test Plan

➢ Validate Model

➢ Present a technical paper on HybSim model

➢ Build a User's Group.

Develop User's Test Plan

➢ Allows users to become familiar with the model in a staged process.

➢ Three levels of detail, with increasing levels of sophistication

1. Allows user to run a pre-loaded case to assure that correct input and output is obtained

2. Walks users through the development of a modeling case, indicating the correct values and input location. Test Plan presents correct output.

3. Presents a case of a hypothetical village power system and allows users to construct the model case from scratch. Test Plan presents likely output.

➢ Delivered Test Plan in May 2004

FY2004 Tasks

- **Model Validation**

  - Criteria: Measure model performance against actual hybrid system performance.
  - Developed criteria for measuring performance indices
  - Battery Replacement at Lime Village will permit final validation
  - Ran against other hybrid systems to compare general parameters.

Validation Criteria

Developed a Model Validation Equation

$$Rating\ Score = W_F*(1\text{-}F\%) + W_S*(1\text{-}S\%) + W_{SP}*(1\text{-}SP\%) + W_B*(1\text{-}B\%)$$
$$+W_D*(1\text{-}D\%) + W_T*(1\text{-}T\%) + W_t*(1\text{-}t\%)$$

Where W = Weighting factor

Model Validation Equation Weighting Factors

Index	Abbr.	Weight	Acceptable Error Band
Fuel Usage	F	25	+/- 5%
Solar Energy Generated	S	20	+/- 5%
Peak Solar Power	SP	5	+/- 10%
Battery Energy Consumed	B	15	+/- 5%
Diesel Energy Generated	D	10	+/- 5%
Total Energy Consumed	T	20	+/- 5%
Time Displacement	t	5	+/- 20%

HybSim Validation Plot

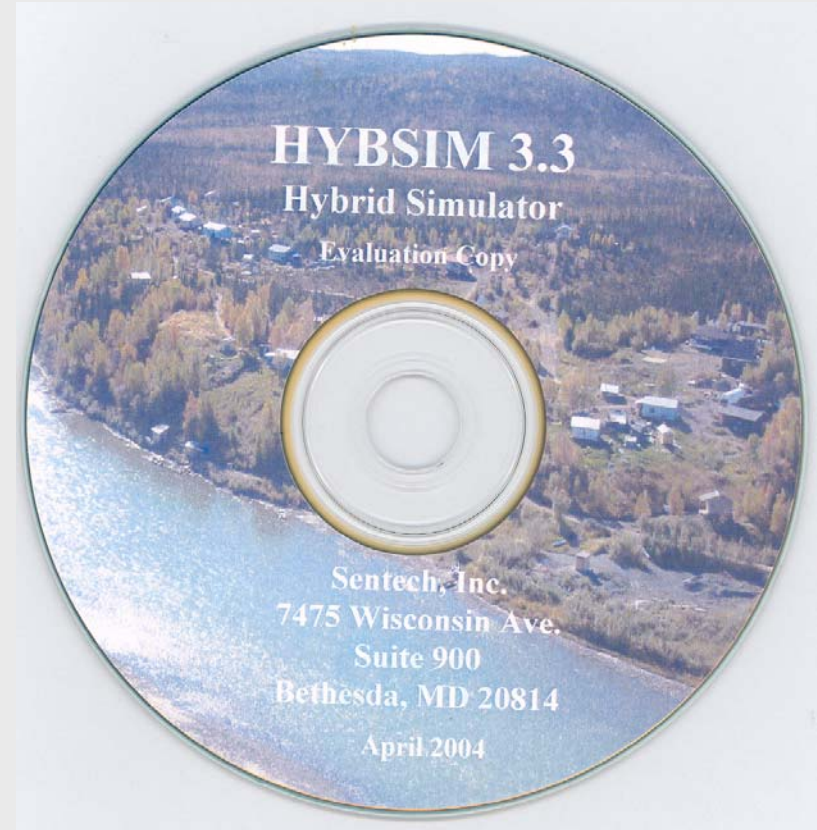
Grasmere vs. Hybsim Validation Chart

Promoted HybSim Usage in Alaska

- ➢ Presented technical paper at 2004 Rural Energy Conference in Talkeetna, Alaska

- ➢ Enthusiastic response from participants.

Build User's Group

➢ **Distributed 25 copies of model to conference attendees in Alaska for beta testing.**
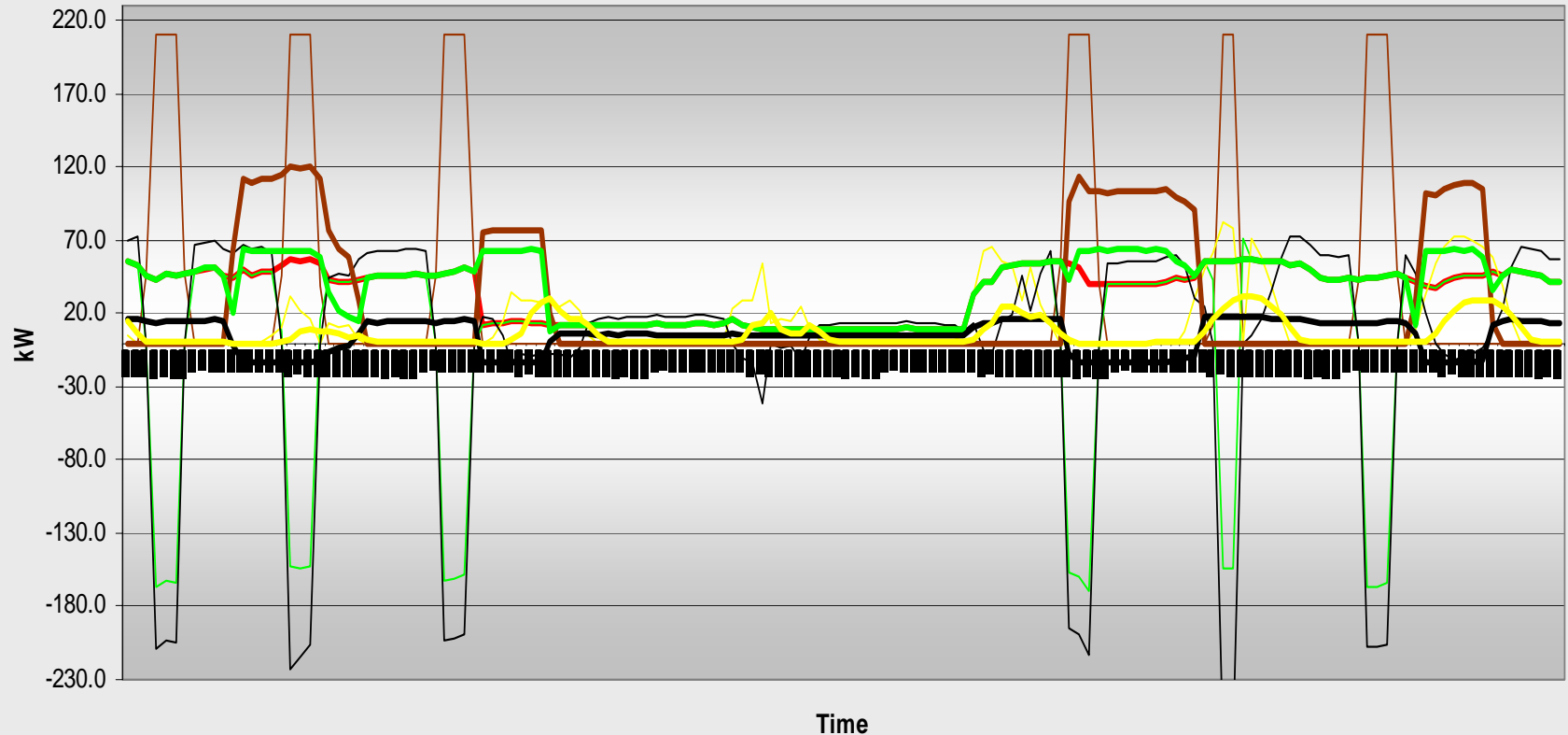
Build HybSim User's Group

➢ **Built Database of Users in Alaska**

  ➢ Seventeen attendees of August 2003 User's Workshop in Anchorage, Alaska

  ➢ Twenty-five Talkeetna Rural Energy Conference attendees showing interest in the model for beta testing.

  ➢ Talkeetna Conference Attendee list of over 200 persons who are Rural Energy Utilities, Villages, and Electric Cooperatives.

Future (FY05) Tasks

➢ **HybSim 3.3**

➢ **Prepare for production**

  ➢ Complete HybSim Model validation

  ➢ Improve User-interface

    ➢ Simpler Dialogue boxes

    ➢ Improve financial calculation and output

  ➢ Transfer ownership and make available for general usage.

  ➢ Making downloadable from internet

    ➢ SENTECH will take this task on as AEA has difficulty in supplying trained personnel.

FY05 Work

- **Lime Village and Data Acquisition**
  - Install Replacement Battery
    - (Given the remote location, upgrade/replacement progress is slow)
  - Complete Lime Village performance optimization
  - Finalize the data acquisition system
    - Lime village real time data retrieval
    - Web-based data

Conclusions

- ➤ **Lime Village Project has provided concrete benefits to the Alaska Energy Authority**

- ➤ **Demonstrated improvements in Lime Village system performance**

- ➤ **HybSim is a simple, yet valuable tool for analyzing village power systems and could be used in rural villages worldwide.**

- ➤ **HybSim Model is near production point**
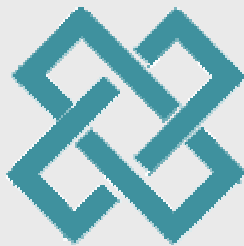
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Questions?